

Deriving Growing Season Metrics from MODIS EVI and a Simple Bioclimatic Index

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OBJECTIVE

Test whether general phenological behaviour can be accurately characterised at monthly intervals using MODIS EVI data

GROWING SEASON INDEX

- Index to quantify greenness of vegetation during the year^[1] (Fig. 1)
- Uses 3 dimensionless climatic modifiers to account for variations observed in seasonal phenology (Fig. 2a-c)

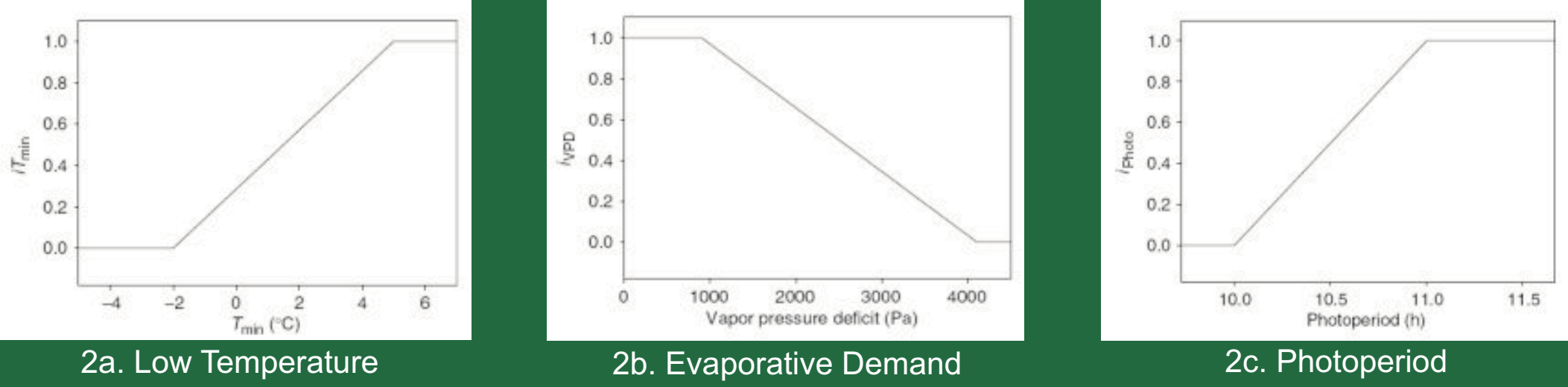
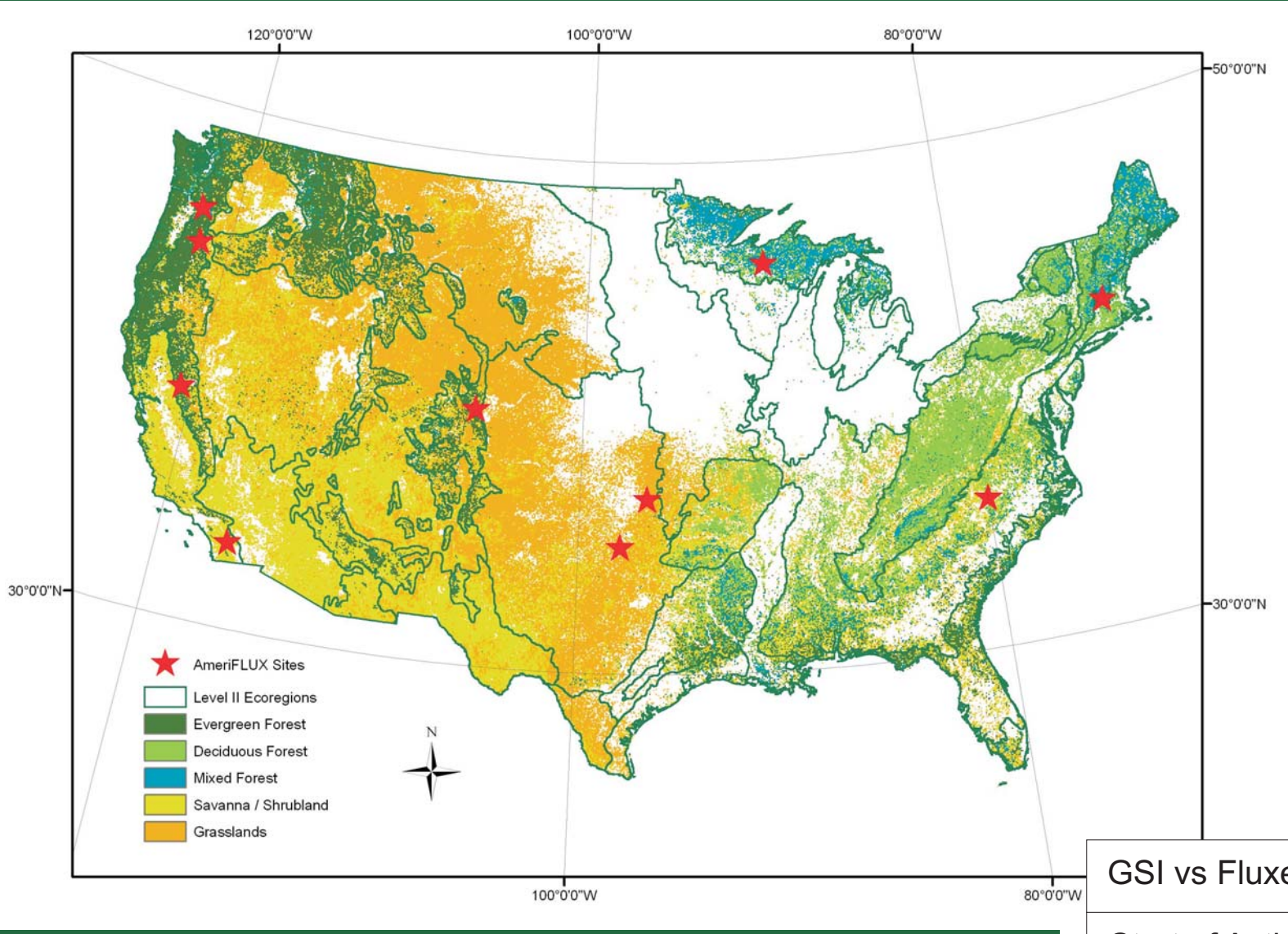


Fig. 2: Climate modifiers controlling vegetation phenology employed by the GSI model

HOW ACCURATE IS THE GSI?



- Monthly GSI compared to seasonal patterns of daytime CO₂ uptake from 12 Ameri-FLUX sites (Fig. 3 and Table 1)

Fig. 3: AmeriFLUX CO₂ sites, Level II Ecoregions & IGBP Land cover

Table 1: Significant correlations ($p < 0.05$) between GSI and Flux data for start and length of growing season

	GSI vs Fluxes	All IGBP Classes	IGBP Forest Classes
Start of Activity	0.57	0.82	
End of Activity	0.27	0.21	
Length of Activity	0.65	0.87	

COMPARISON WITH MODIS EVI

- MODIS EVI - satellite measure of vegetation greenness (Fig. 4.)
- Analysis based on EPA Level II ecological zones across the USA and dominant MODIS derived IGBP class (forest / non-forest) (Fig. 3)
- Significant associations in seasonal phenology for forest as opposed to non-forest classes (Fig. 5)

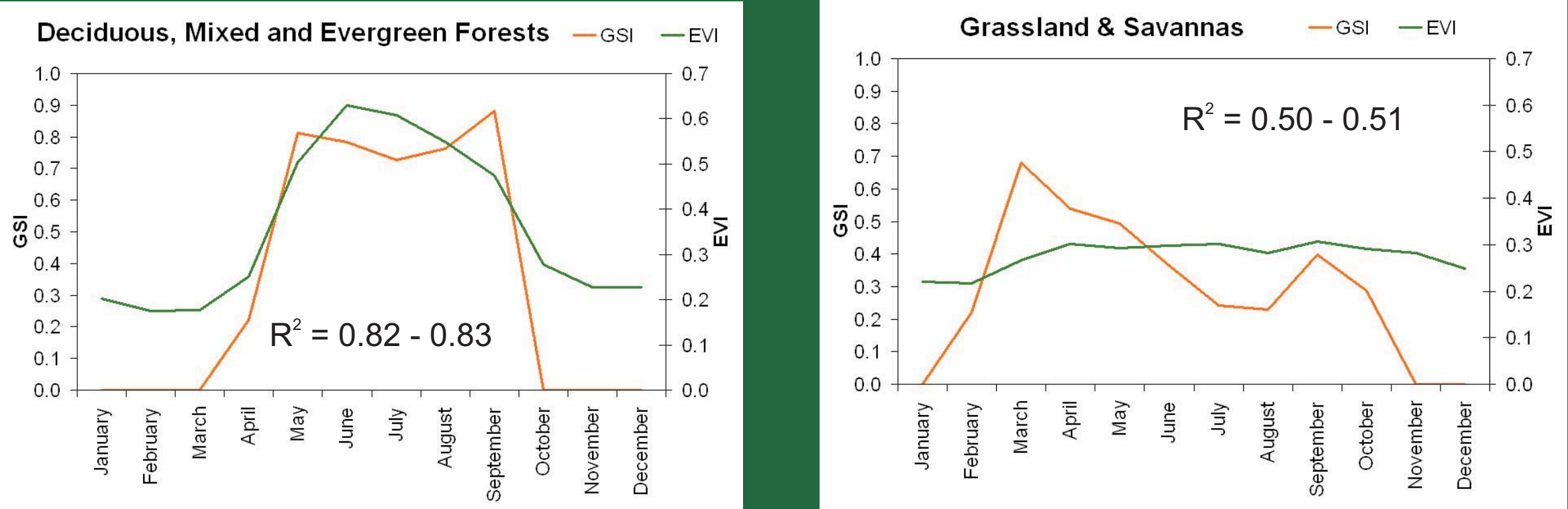


Fig. 5: Seasonal greenness of forest versus non-forest land cover types depicted with the GSI and EVI

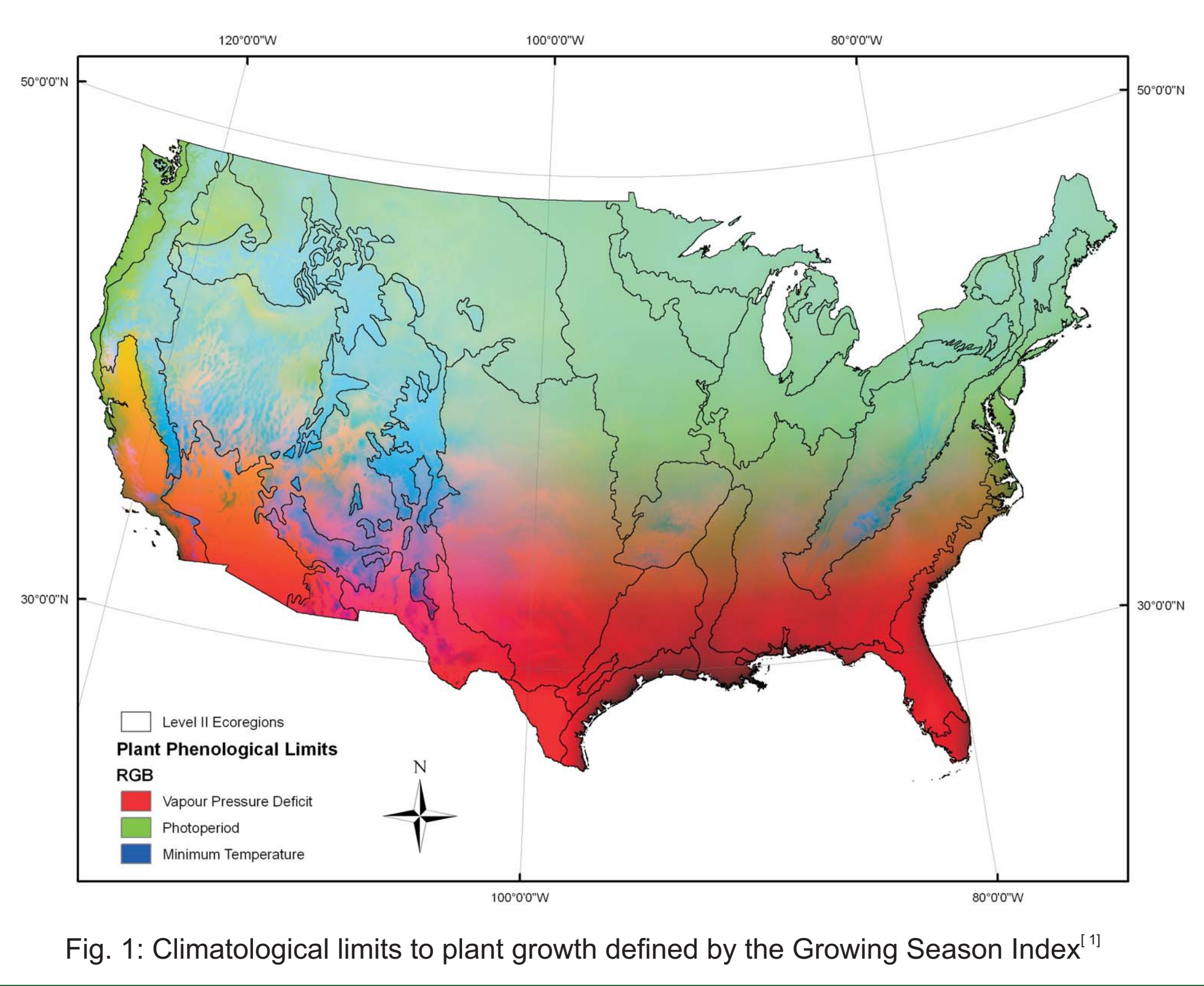


Fig. 1: Climatological limits to plant growth defined by the Growing Season Index^[1]

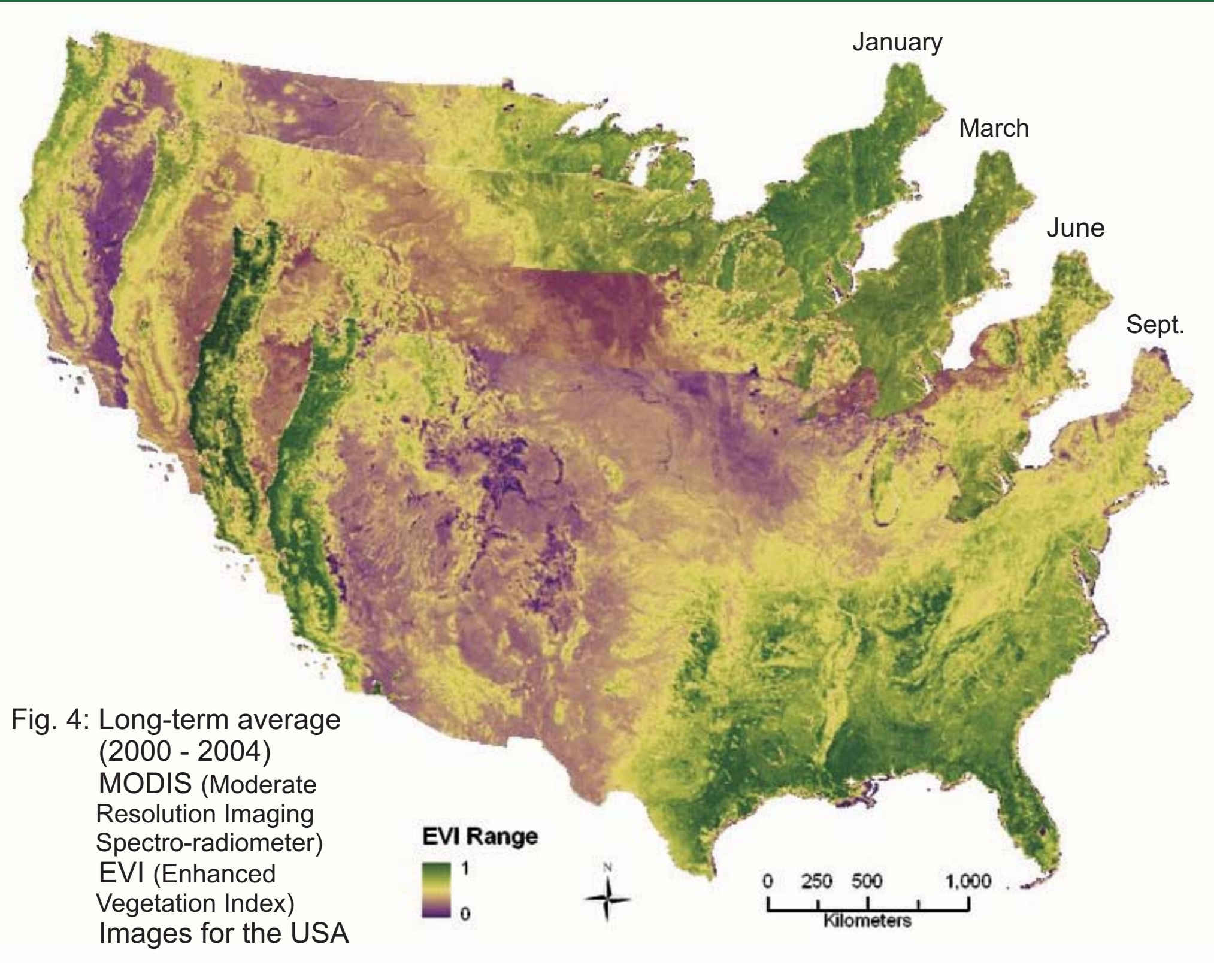


Fig. 4: Long-term average (2000 - 2004) MODIS (Moderate Resolution Imaging Spectro-radiometer) EVI (Enhanced Vegetation Index) Images for the USA

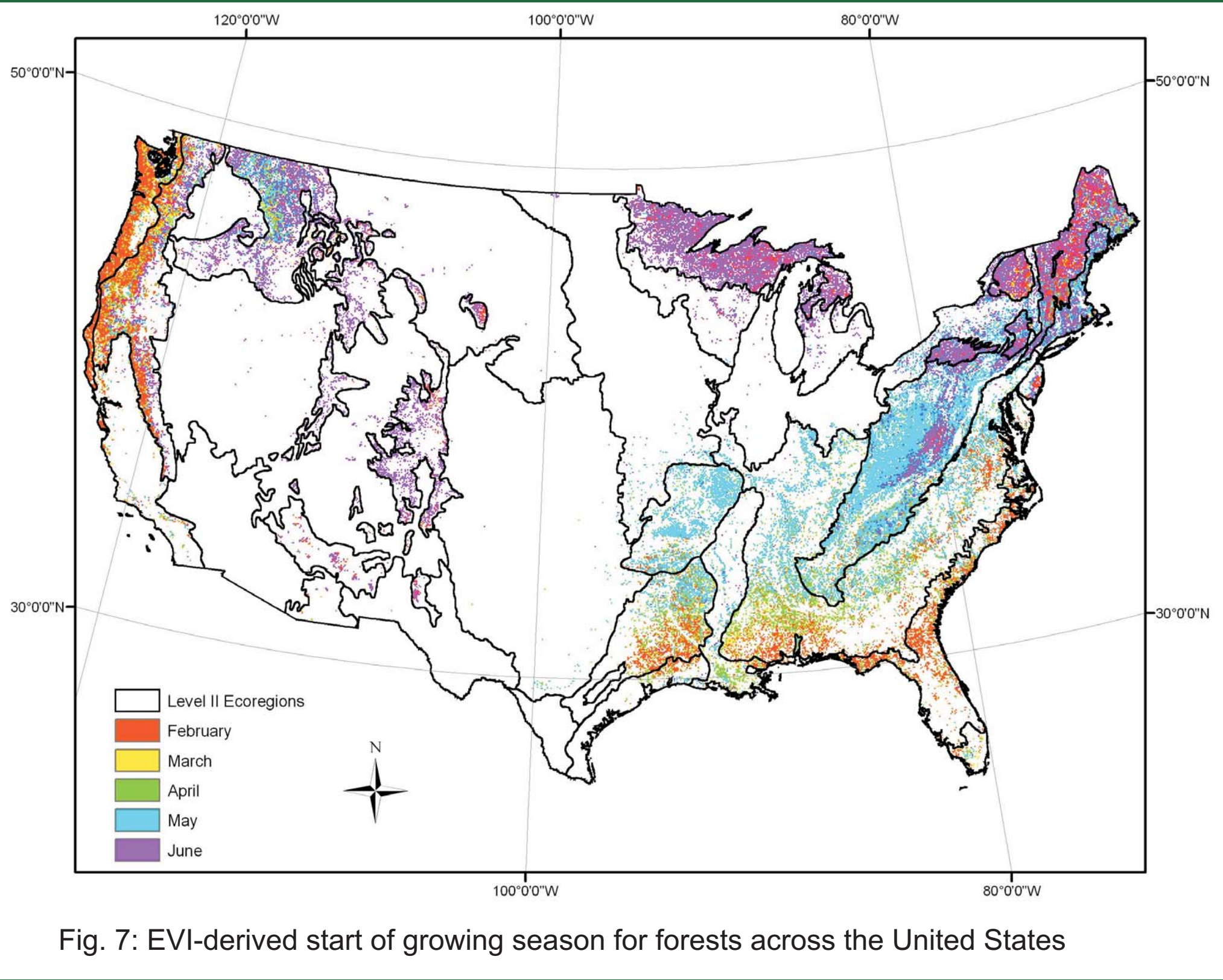


Fig. 7: EVI-derived start of growing season for forests across the United States

GROWING SEASON METRICS

- Thresholds to define Start and End of GSI and EVI growing seasons (Table 2 and Fig. 6)

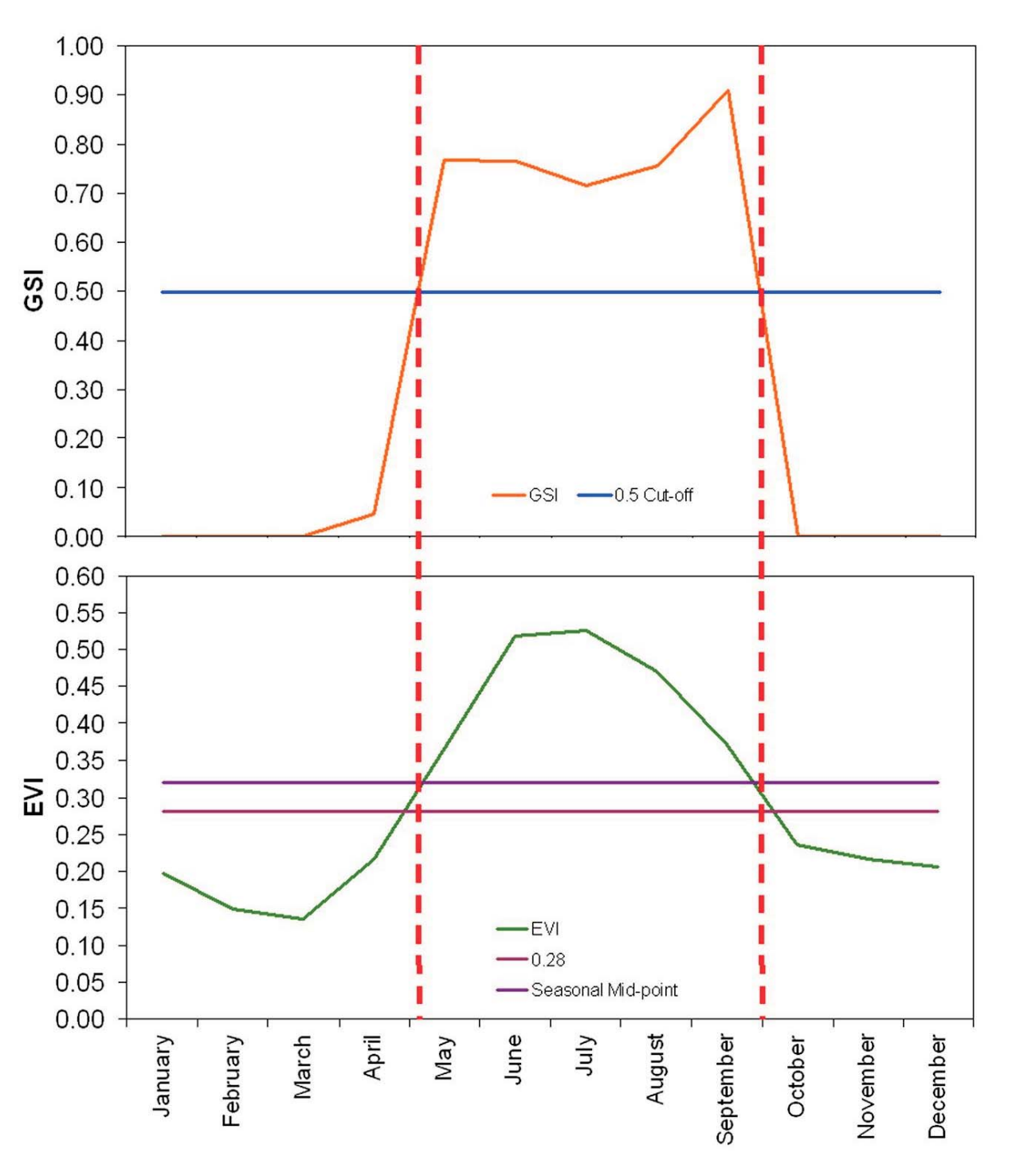


Table 2: Thresholds applied to the GSI and EVI long-term average data to derive growing Season metrics

Threshold	Value	Description
GSI	0.5 ^[1]	>0.5, sustained canopy
EVI	Seasonal Mid-point ^[2]	Half-max of long-term av.

Fig. 6: Schematic diagram showing derivation of growing season metrics using defined thresholds

- Poor association between GSI and independent measure (SM) of EVI growing season start, end and length (Table 3)

Table 3: Association between GSI and independent estimate of EVI growing season metrics

Veg Type	GSI Start	EVI Start	GSI End	EVI End	GSI Length	EVI Length
Forest	March	April	September	October	6 months	7 months
Non-Forest	January	February	September	November	7 months	4 months
R ²	0.34		0.00		0.24	

- GSI used to provide thresholds to define EVI growing season attributes for forest (0.28) & non-forest (0.22) classes (Fig. 6)
- Improved relationship between GSI & EVI Start ($R^2 = 1$), End ($R^2 = 0.62$) and Length ($R^2 = 0.35$) of forest growing season metrics (Fig. 7)

CONCLUSIONS

- Monthly phenological behaviour of forests can be accurately characterised using the MODIS EVI across the continental USA
- GSI and EVI are less useful in defining the growing season attributes of vegetation with low canopy densities (i.e. grassland and savannas)

ACKNOWLEDGEMENTS & REFERENCES

We acknowledge support for this research from NASA (NNG04GK26G)

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[1] Jolly, M. *et al.* 2005. A generalised, bioclimatic index to predict foliar phenology in response to climate. Global Change Biology. 11: 619-632.

[2] Schwartz, M.D. *et al.* 2002. Assessing satellite-derived start of season measures in the conterminous USA. International Journal of Climatology. 22: 1793-1805.

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